Manure Handling and Storage Effects on Nitrogen Losses of Dairy Farms

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Overview

- ✓ Brief identification of the problem;
- ✓ Processes involved in ammonia volatilization;
- ✓ Methods for estimating nitrogen losses;
- ✓ Sources of ammonia volatilization;
- ✓ Summary.

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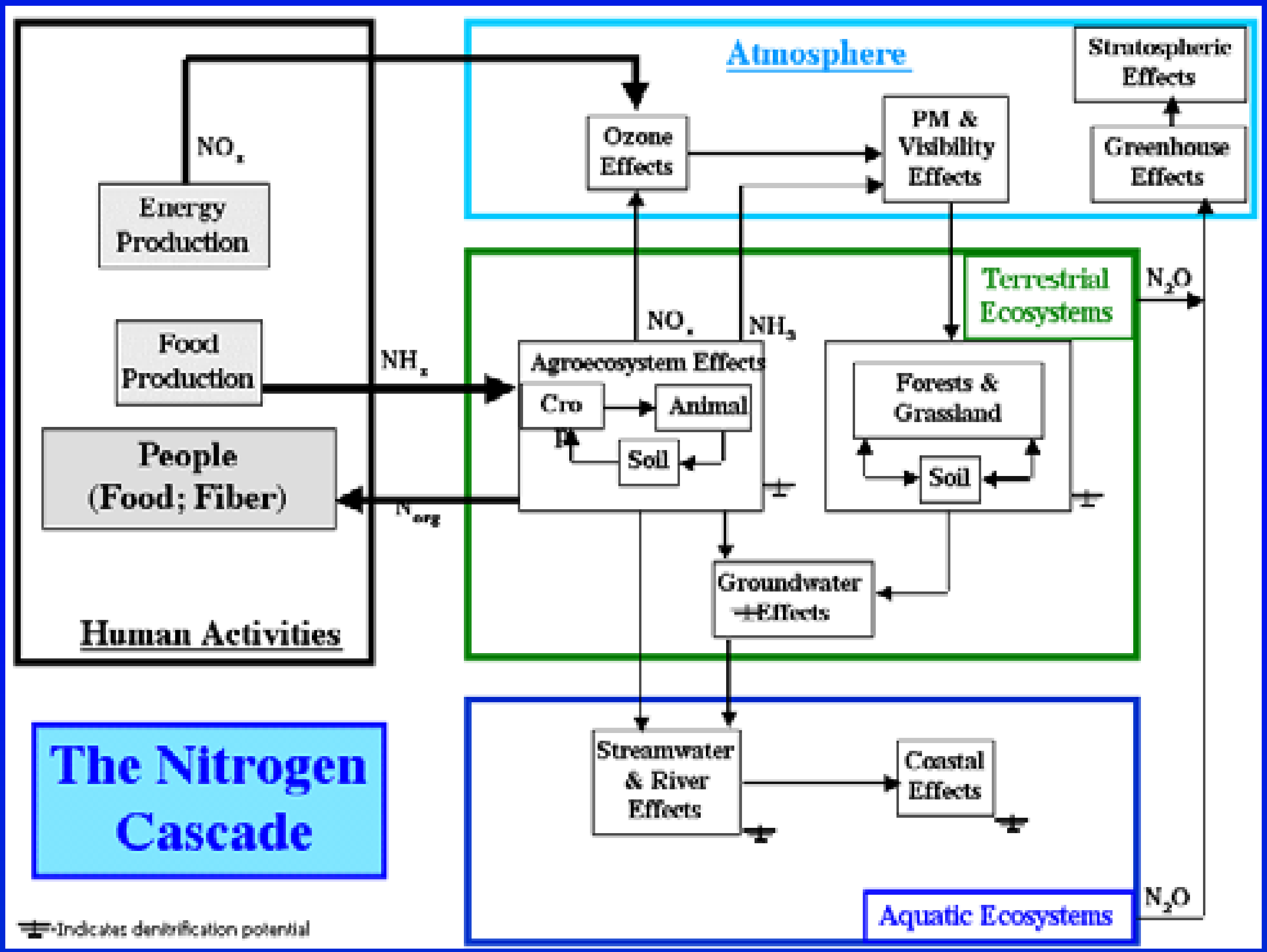
Introduction

- Enhanced Integrated Nutrient Management on Dairy Farms

Why has nitrogen management become an issue?

Jim Galloway s N cascade



N-Conference (2001)

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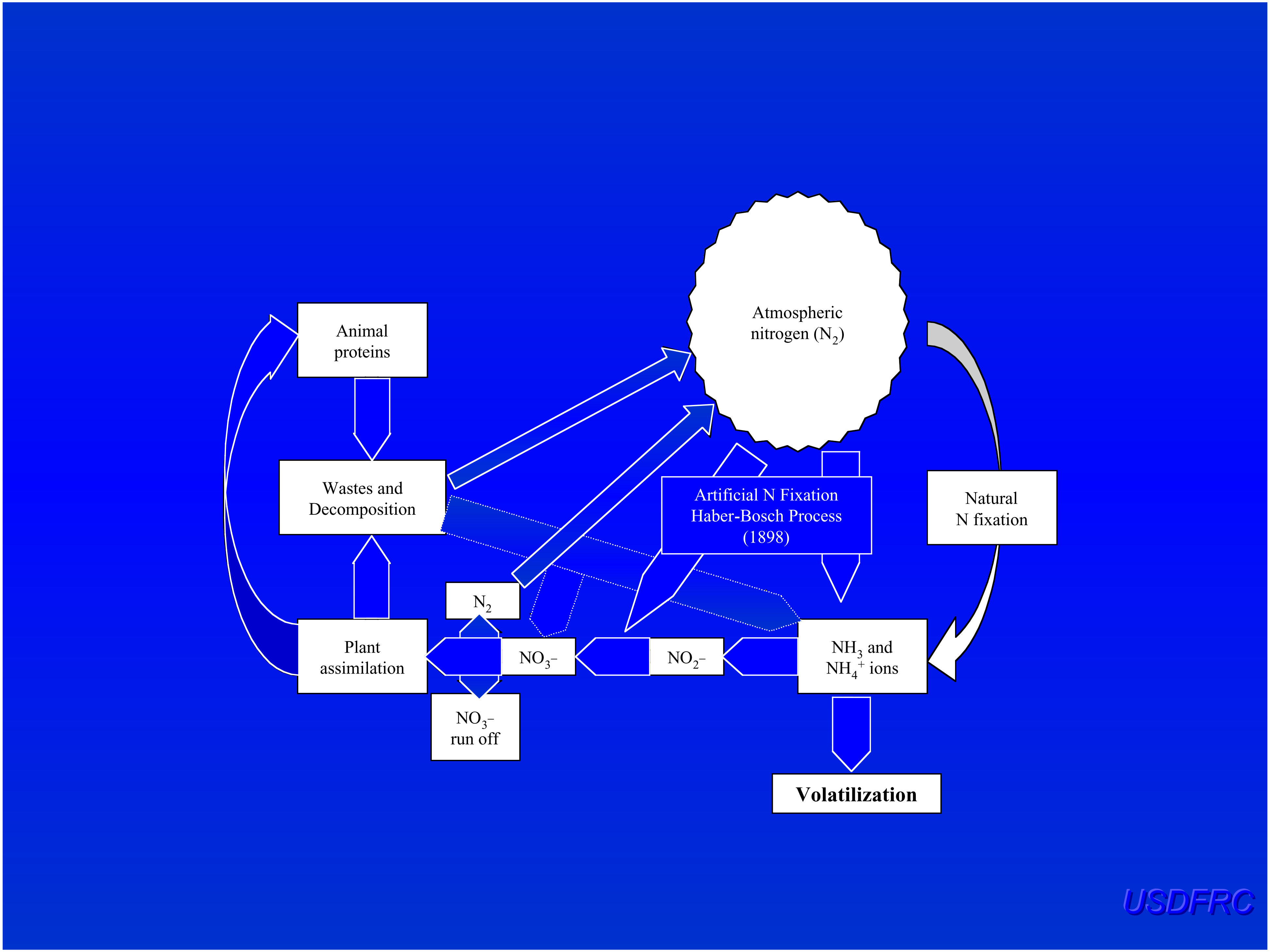

Atmospheric nitrogen (N_2)
Animal proteins
Wastes and Decomposition
Artificial N Fixation
Haber-Bosch Process
(1898)
Natural N fixation
Plant assimilation
N_2
NO_3^-
NO_2^-
NH_3 and NH_4^+ ions
NO_3^- run off
Volatilization
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Effects of excessive ammonia in the atmosphere

¥ Effects to human and animal health:

Ammonia levels	**Health effects**
— 5ppm	Olfactory detection
— 20-25ppm	Eye irritation
— ~ 1,500ppm	Cough and froth at the mouth
— 5,000ppm	Deadly

ISU Extension publication #: Pm-1518k

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Effects of excessive ammonia in the atmosphere

¥ Effects to human and animal health:

— Reacts with sulfur dioxide (SO_2) and nitrogen oxides (N_xO) ➔ Aerosols.

* Clean Air Act enforces PM10;

— Odor problems.

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Effects of excessive ammonia in the atmosphere

¥ Effects on environment:

—50% of NH_3 is deposited within a 50-km (31 miles) range;

—Farther deposition is halved every 400 km (250 miles).

¥ Reduces visibility (haze);

¥ Reduction of biodiversity: affect natural ecosystems through N enrichment and allow shift from native oligotrophic plant communities to competitive grass species;

¥ Acid rain;

¥ Eutrophication (nitrate): Gulf of Mexico Hypoxia Zone (Burkart and James, 1999).

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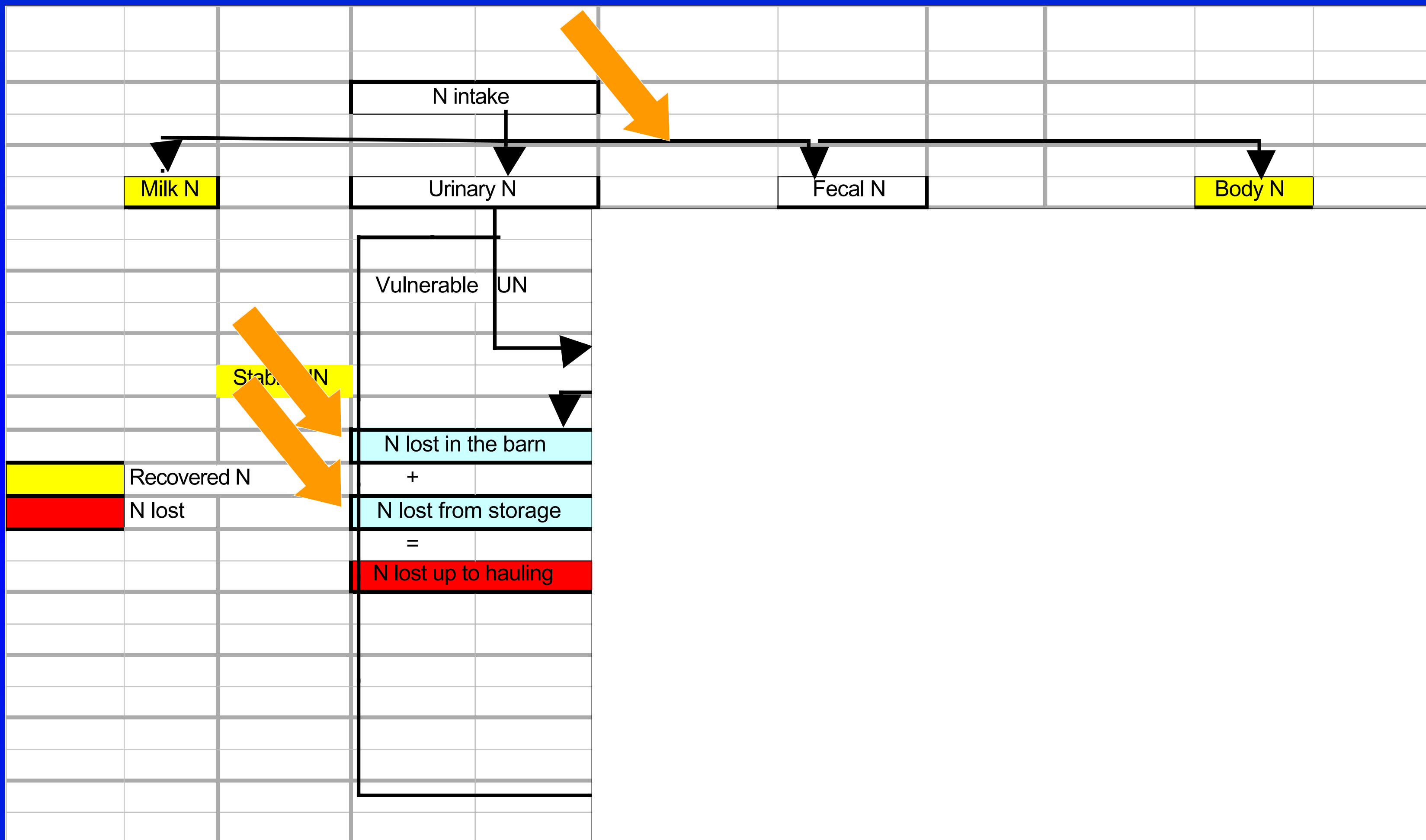
Where does ammonia come from in dairy farms?



N intake
Milk N
Urinary N
Fecal N
Body N
Vulnerable UN
Stab... N
N lost in the barn
+
N lost from storage
=
N lost up to hauling
Recovered N
N lost

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Factors affecting N efficiency in a dairy cow:

¥ N efficiency (kg milk N / kg feed N)

- Maximum theoretical: = ~.44 (NRC, 2001);
- 56 experiments: .26 (range: .17-.39);
- Grazing N fertilized pastures: .16 (Vuuren and Meijs, 1987).

* Reducing dietary N → increase efficiency (and risk?).

Factors affecting N efficiency in a dairy cow:

	kg/d	lb/d
DMI	24.5	54.0
Diet CP, %	17.5	
N intake	0.686	1.51
Milk yield	37	81.5
Milk CP, %	3.10	
Milk N	0.180	0.396
N retention	0.034	0.076
Excreted N*	0.472	1.039
% excreted	68.8	

* Excreted N = urinary N + fecal N

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N distribution in dairy manure

- ¥ Fecal N:
  - —Undigested feed;
  - —Microbial proteins;
  - —Metabolic losses.

- ¥ Urinary N:
  - —Urea (50-90%);
  - —Allantoin;
  - —Uric acid;
  - —Creatinine;
  - —Creatine;
  - —Hippuric acid;
  - —Xanthine, Hypoxanthine, free ammonia, free amino acids

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Urea breakdown

$$CO(NH_2)_2 + H_2O \xrightarrow{\text{urease}} 2NH_3 + CO_2$$

* Complete within 2-6h at T > 10°C (50°F - Muck, 1982, Elzing & Monteny, 1997)

Ammonia dissociation

$$NH_4^+ \rightleftharpoons NH_3 + H^+$$

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

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Processes involved in ammonia volatilization from dairy manure

¥ NH_3/NH_4^+ reaction tends to NH_3 with increase in:

– Temperature (Muck and Steenhuis, 1981, Muck, 1982);

– pH (Muck and Steenhuis, 1981, Muck, 1982);

– NH_4^+ concentration (Hashimoto, 1972);

– Wind speed (Monteny and Erisman, 1998).

¥ May reduce volatilization:

– Floating layers (Voorburg and Kroodsma, 1992).

Modeling N Split Between Urine and Feces

- ¥ Introduction:
- ¥ Objective:
  - —To develop a regression to predict N split between urine and feces based on simple information.
- ¥ Literature review:
  - —56 experiments, 231 different treatments, 3751 cows.
  - —Literature up to 11 years old (1990-2001).

Modeling N Split Between Urine and Feces

– Information obtained:

- # cows
- Breed
- BW (kg)
- Lactation
- DIM
- Type of Exp.
- Form of diet
- Main Forage
- Method of preservation
- # feedings
- %Forage
- CP (%DM)

- RUP (%CP)
- TDN (%DM)
- NDF (%DM)
- NFC (%DM)
- DMI (kg/d)
- Milk (kg/d)
- NI (kg/d) measured
- Milk CP (%)
- Milk N (kg/d)
- Manure N
- Fecal N
- Urinary N
- NR (kg/d) measured

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Modeling N Split Between Urine and Feces

—Calculations

- NI (kg/d) calculated
- Fecal N (%DMI)
- Fecal N (%NI)
- Estimated Fecal N (Peyraud et al., 1995 - 7.5g/kgDMI)
- Estimated Fecal N (Van Soest, 1994 —0.6%DMI)
- Estimated Fecal N (Average, 2001 — 0.93%DMI)
- Urinary N (%DMI)
- Urinary N (%NI)

- Urine N, %manure N
- (NI-MN-FN) kg/d
- UN+RN (NI-MN-FN) kg/d
- RN (NI-MN-FN-UN) kg/d
- Manure N (NI-MN) kg/d
- DMI (%BW)
- NI (%BW)
- NDFI (kg/d)
- DMI-CPI-NDFI
- N efficiency

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Modeling N Split Between Urine and Feces

¥ Experimental and dietary information

	Average	Stdev
# feeding	2.50	2.20
%Forage	57	16
CP (%DM)	**16.8**	2.50
RUP (%CP)*	33.0	6.2
TDN (%DM)*	70.6	5.80
NDF (%DM)	38.3	6.50
NFC (%DM)*	41.4	7.80

* Estimated based on book values of dietary ingredients.

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Modeling N Split Between Urine and Feces

- ¥ Production and excretion information

	Avg (kg/d)	Stdev	Avg (lb/d)
DMI	18.0	4.80	39.6
Milk	28.5	7.20	62.8
NI	0.495	0.162	1.09
Milk CP (%)	3.11	0.220	
Milk N	0.137	0.034	0.302
Manure N	0.342	0.114	0.753
Fecal N	0.166	0.058	0.366
Urinary N	0.176	0.068	0.388
NR	0.029	0.035	0.063

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Modeling N Split Between Urine and Fecess

¥ Estimating fecal N:

		Average	stdev
	Fecal N (%DMI)	0.914	0.174
	Fecal N (%NI)	33.4	6.01
Peyraud et al., 1995	**Fecal N (kg/d)**	0.141	0.036
	% error	14.7	18.0
Van Soest, 1994	**Fecal N (kg/d)**	0.113	0.028
	% error	31.7	14.4
Average, 2001	**Fecal N (kg/d)**	0.172	0.043
	% error	-3.99	22.0

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What techniques can be used to estimate N losses?

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Methods for estimating nitrogen losses

- ¥ Direct measurements:
  - —Continuous measurement:
    - ¥ Non Dispersive Infra Red (NDIR);
    - ¥ Open-Path Fourier Transform Infrared (OP-FTIR);
    - ¥ Optical absorption techniques
    - ¥ Fluorescence methods;
    - ¥ Gas chromatography;
    - ¥ Electrochemical cells;
    - ¥ NO monitor in combination with a high temperature catalyst stainless steel (chemiluminescence detectors);
    - ¥ Continuous flow denuder.

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Methods for estimating nitrogen losses

- ¥ Direct measurements:
  - —Discontinuous measurement:
    - ¥ Acid scrubbers;
    - ¥ Gas detection tubes;
    - ¥ Passive diffusion devices;
    - ¥ Denuders.

* Product of air exchange rate and the difference between inflow and outflow NH_3 concentrations.

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Methods for estimating nitrogen losses

¥ Indirect estimations:

- —Mass balances (N Inputs minus N outputs — van der Meer, 2001);
- —N:ash (Muck and Richards, 1983, Muck et al, 1984);
- —N:P.

* Do not discriminate among N form (NH_3, NH_4^+, N_2O or N_2);
* Not real-time .

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Sources of ammonia volatilization

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Opportunities for losses

¥ Cattle housing system

– Floor barn
  - ¥ Tie-stall;
  - ¥ Free-stall:
    - – Slatted floor;
    - – Solid floor;

– Storage
  - ¥ Daily haul;
  - ¥ Earthen basin or concrete pit;
  - ¥ Bedded pack;
  - ¥ Stack.

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Validation Protocol

Moreira, V.R., Santos, H.H.B., Satter, L.D.

- Introduction
- Objectives
  - To evaluate the use of N to P ratio for estimating N disappearance from manure;
  - To determine N disappearance from tie-stall and free-stall.

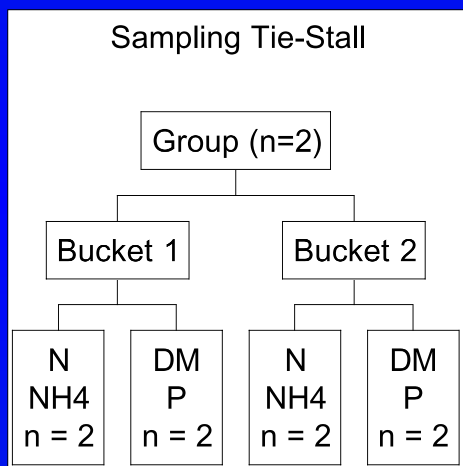
Validation Protocol

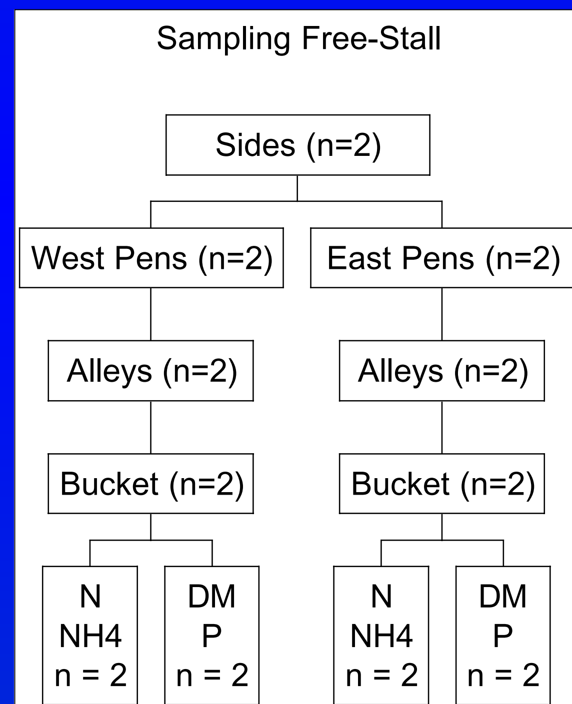
¥ Materials and methods

	Tie-stall	Free-stall
Dates	Feb 9-10th 2001	Feb 9-10th 2001
# Groups	2	2
# Cows	8	~96
Diets	1	2 (P = .38 & .48%DM)
DMI	Individually	Average
MY	Individually	Individually
# scraping per day	2	6-10
Sampling	2x (4:40am & 3:00pm)	3x (7:00pm; 1:00am; 9:00am)

Validation Protocol

- Materials and Methods





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Validation Protocol

- Results
  - Manure temperature (^{o}C) and pH:

Tie-Stall		Group 1 & 2
T1 = 4:40AM	pH	7.98
	Temp	14.9
T2 = 3:00PM	pH	7.56
	Temp	14.5

Free-Stall		Pen 5 + 6	Pen 7 + 8
T1=7:00PM	pH	8.61	8.04
	Temp	7.90	8.25
T2=1:00AM	pH	8.15	8.17
	Temp	6.50	7.10
T3=9:00AM	pH	7.97	7.78
	Temp	5.85	6.40

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Validation Protocol

¥ Results

—TN and TP:

	TN (%Wet)	P (%Wet)
Free stall - Pen 5-6	0.455	0.051
Free stall - Pen 7-8	0.464	0.070
Tie stall - Diet UN	0.502	0.042

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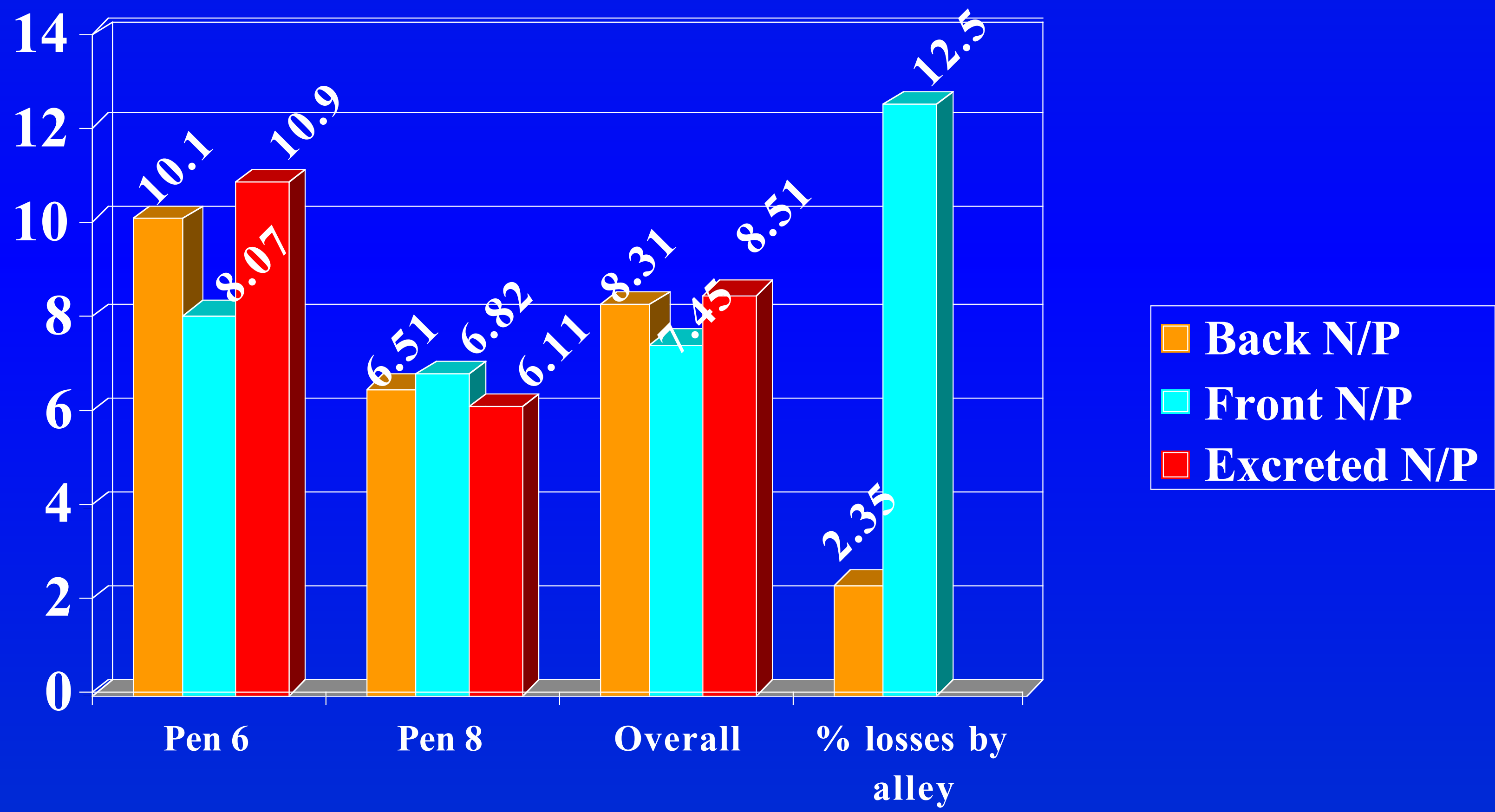
Validation Protocol

Free-stall



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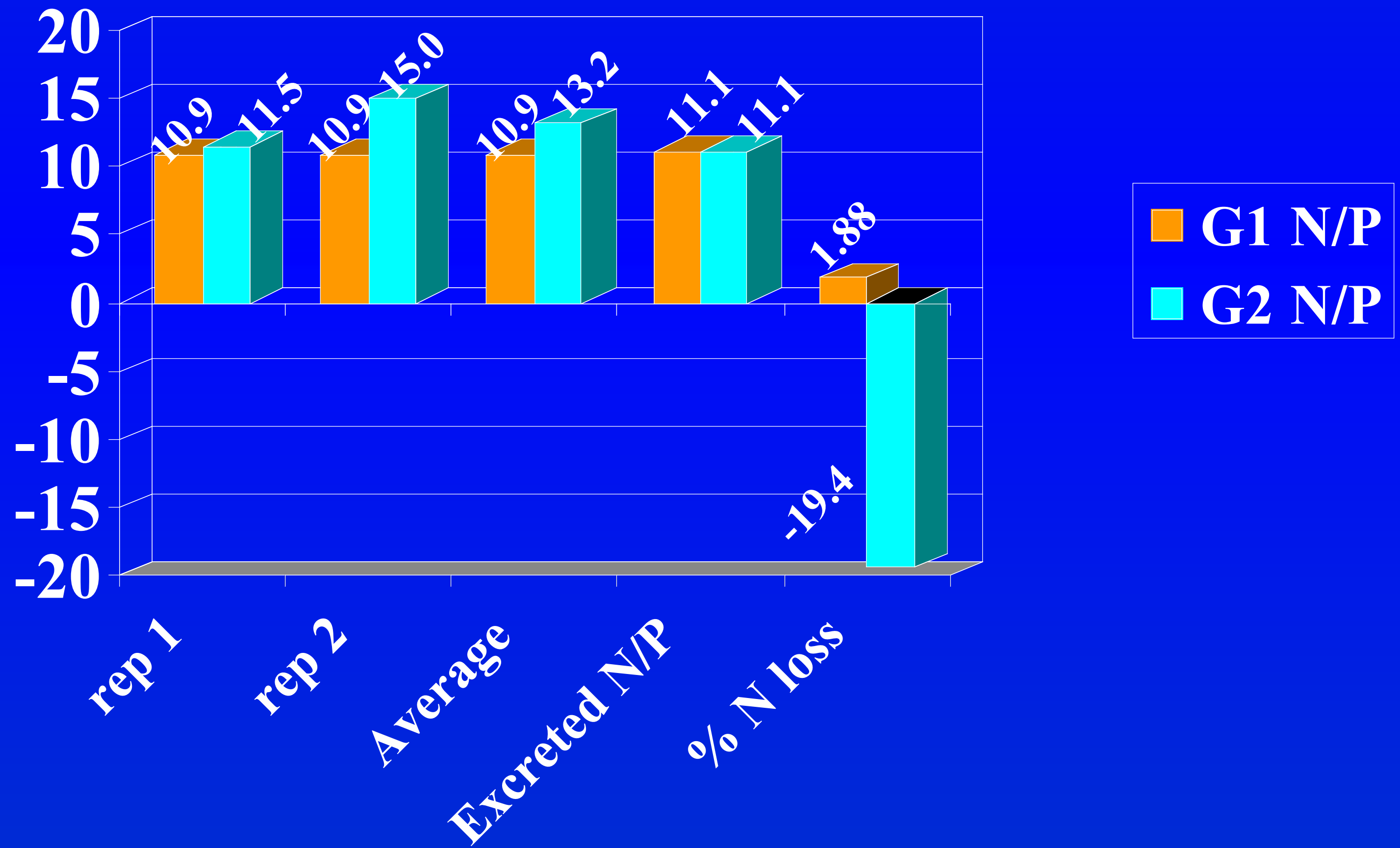
Validation Protocol

Tie-stall



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Freeze Drying TN Protocol

- Introduction
- Objective
  - To evaluate the freeze drying process on the recovery of manurial total nitrogen.
- Materials and Methods
  - 2x2x3 factorial design:
    - With or without acidification (2mL 67% H_2SO_4/90mL manure);
    - Three levels of ammonium sulfate (0, 3 or 6g/~90mL manure);
    - Analyzed fresh or after lyophilization
  - 5 replications/treatment.

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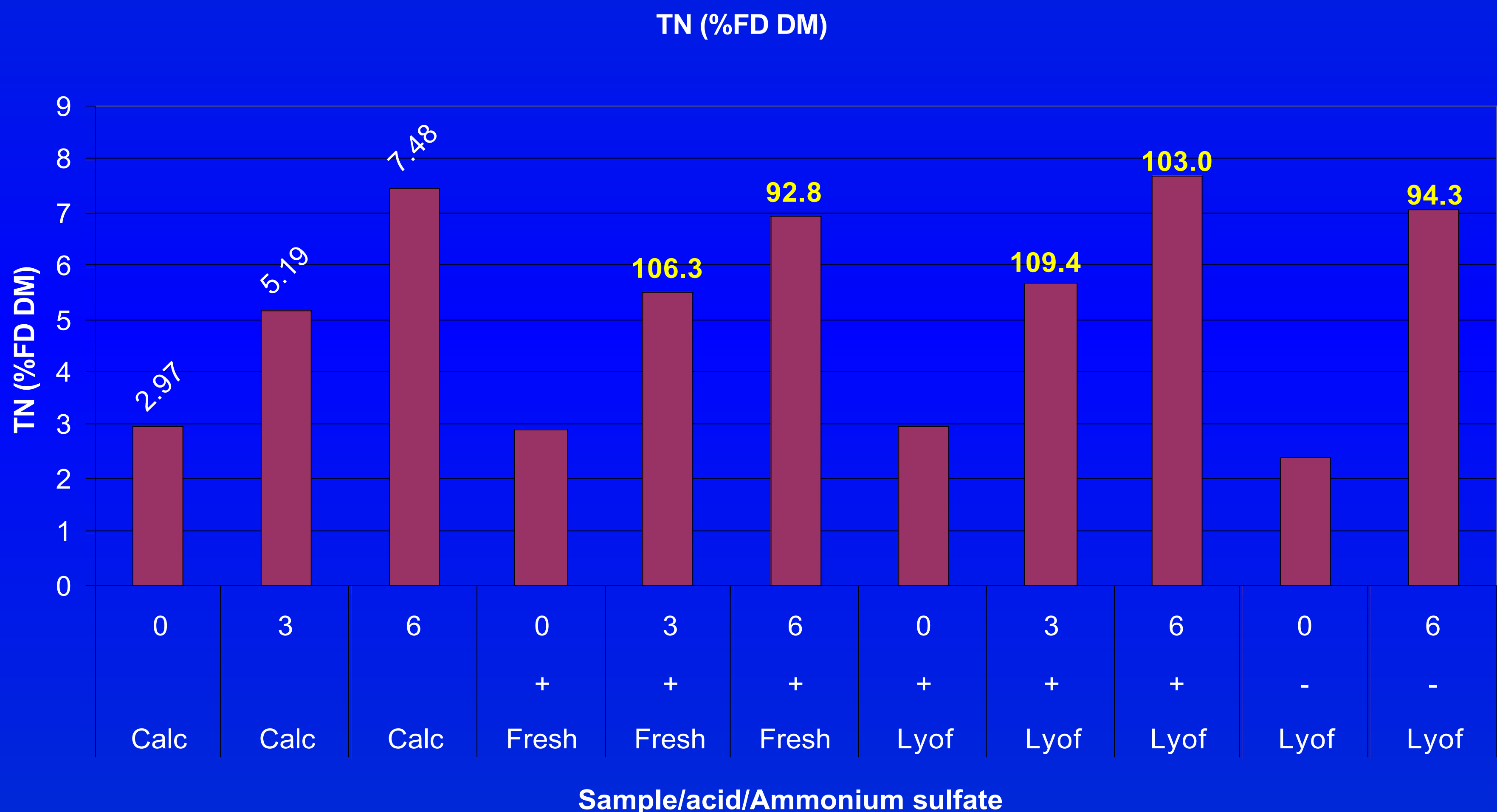
TN Protocol

- ¥ Results



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TN Protocol

¥ Results

Effect of lyofilization and acidification manure samples on total nitrogen recovery (TN):

Sample	**Fresh**			**Lyofilized**						
Sulfuric acid	+			+			-			
g $(NH_4)_2SO_4$	**0**	**3**	**6**	**0**	**3**	**6**	**0**	**6**	**SEM**	***P*** $\leq$
TN (%FD DM)	2.91^{d}	5.52^{c}	6.94^{b}	3.00^{d}	5.69^{c}	7.71^{a}	2.40^{e}	7.06^{b}	0.13	0.001
(Rep) CV (%)	9.04	8.17	8.80	5.66	3.00	2.05	2.15	2.11		
Rep CV (%)	4.39	3.55	5.14	6.85	1.56	4.88	4.34	2.39		

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On-Farm Estimations

¥ Introduction

¥ Objective

—To estimate N disappearance from dairy manure from excretion until storage is emptied using P as a marker (N to P ratio).

On-Farm Estimations

- ¥ Materials and methods
  - —13 farms were selected;
  - —Samples collected:
    - ¥ Manure samples: collected throughout emptying of storage facility;
    - ¥ Feed samples;
    - ¥ Sampling period: March 27th through May 29th 2001

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On-Farm Estimations

- Materials and methods
  - Information:
    - Housing (type and management);
    - Milk records and diet composition (N and P);
    - Manure storage (type and management);
    - Hauling schedule.

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On-Farm Estimations

- Materials and methods
  - Sample processing was similar to that of Validation Protocol;
  - TN analyses were done in half of the sub-samples that were lyophilized.

On-Farm Estimations

¥ Results

	pH	T (^{o}C)	DM (%)	TN (%DM)	Ash (%DM)	P (%DM)	N:P
Overall avg	7.31	14.98	12.28	3.33	36.7	0.63	5.54
Sand bedding	7.40	15.6	15.2	2.79	51.2	0.47	5.91
Sawdust bedding	7.19	14.1	8.73	3.99	19.2	0.81	5.09
Stdev	0.48	5.30	4.38	0.82	17.4	0.21	0.82
CV	6.58	35.4	35.7	24.6	47.4	33.5	14.9
Max	8.52	23.7	19.8	4.34	58.3	0.92	6.49
Min	6.85	6.34	6.73	1.74	17.1	0.36	4.03

On-Farm Estimations

¥ Limitations

Farm	2	3	4	5	6	7	8	9Lact	9Dry	10	11	12	13	Avg	Stdev	CV
Cows																
BW (kg)	**635.6**	**?**	**635.6**	**568.2**	**648.2**			**635.6**	**635.6**	**635.6**	**591.6**			623.3	27.8	4.5
DMI (kg)	**25.4**	**?**	**24.9**	**24.9**	**28.2**			**23.6**	**28.8**	**25.8**	**24.5**			25.8	1.8	7.0
DIM	**154**	**?**	**154**	**154**	**154**			**132**	**0**	**154**	**154**			132	54	40.8
MY (kg)	**35.4**	**?**	**34.1**	**35.8**	**42.2**			**29.9**	**0.0**	**36.3**	**35.9**			31.2	13.0	41.8
Milk CP (%)	**3.15**	**?**	**3.15**	**3.15**	**3.15**			**3.15**	**0.00**	**3.15**	**3.15**			2.76	1.11	40.4
Milk P (%)	**0.09**	**0.09**	**0.09**	**0.09**	**0.09**	**0.09**	**0.09**	**0.09**	**0.00**	**0.09**	**0.09**	**0.09**	**0.09**	0.08	0.02	30.0
Diet																
TN (%DM)	**2.78**	**?**	**2.98**	**2.84**	**2.59**			**2.81**	**2.29**	**2.76**	**2.20**			2.65	0.28	10.4
TP (%DM)	**0.48**	**?**	**0.45**	**0.44**	**0.41**			**0.38**	**0.36**	**0.41**	**0.40**			0.42	0.04	9.16
Excretion																
TN (g)	0.531		0.574	0.531	0.522	0.000	0.000	0.514	0.658	0.531	0.362	0.000	0.000	0.352	0.268	76.2
TP (g)	0.090		0.081	0.078	0.078	0.000	0.000	0.064	0.104	0.072	0.066	0.000	0.000	0.053	0.040	76.5
N/P	5.89		7.05	6.80	6.72	#DIV/0!	#DIV/0!	8.08	6.30	7.40	5.49	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
								7.8								
Manure																
TN (%DM)	3.31	6.30	2.88	4.34	3.65	3.53	4.16	2.65		2.51	4.28	1.74	3.63	3.58	1.16	32.4
TP (%DM)	0.564	0.861	0.521	0.814	0.586	0.871	0.883	0.400		0.394	0.919	0.359	0.575	0.645	0.212	32.8
N:P	5.76	7.42	5.39	5.51	6.45	3.99	4.83	6.49		6.20	4.65	5.13	6.44	5.69	0.96	16.9
% N loss	2.1	#DIV/0!	23.5	19.0	4.0	#DIV/0!	#DIV/0!	16.9		16.2	15.4	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

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On-Farm Estimations

	Farms						
	2	**4**	**5**	**6**	**9**	**10**	**11**
N losses (%excreted N)	2.1	23.5	19.0	4.0	16.9	16.2	15.4

Datasets

¥ Introduction

¥ Objective

— Estimate N disappearance from dairy manure based on N to P ratio, according to analyses done in commercial laboratories.

Datasets

¥ Materials and Methods

— 230 dairy manure analyses from three commercial laboratories located in Pennsylvania, Ohio and Wisconsin;

— Analyses: Total Nitrogen and Total Phosphorus.

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Datasets

¥ Results

Effect of manure storage structure on Total Nitrogen (**TN**), Total Phosphorus (**P**) and N to P ratio (**N/P**) (3 Labs: Pennsylvania, Ohio and Wisconsin)

%DM	BP (1)	DH (2)	EB (3)	S (4)	SEM	P≤		
						BP vs. EB	DH vs. EB	S vs. EB
TN	2.41	2.9	4.25	2.73	0.35	<.001	<.001	0.02
P	0.560	0.550	0.790	0.540	0.060	0.001	<.001	0.02
N/P	4.84	5.73	5.56	5.41	0.42	0.16	0.58	0.86

[1] BP = bedded pack (n=19).

[2] DH = daily haul (n=68).

[3] EB = earthen basins (n=136).

[4] S = stack (n=7).

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Datasets

¥ Results

Effect of season[1] on Total Nitrogen (**TN**), Total Phosphorus (**P**) and N to P ratio (**N/P**) of 130 dairy manure analyses (2 labs: Minnesota and Wisconsin), regardless waste storage structure.

						***P* ≤**					
	Summer[2]	**Winter[3]**	**Fall[4]**	**Spring[5]**	**SEM**	**Fall vs. Spring**	**Fall vs. Summer**	**Fall vs. Winter**	**Spring vs. Summer**	**Summer vs. Winter**	**Winter vs. Spring**
TN	4.3	3.84	4.03	3.17	0.48	0.07	0.7	0.79	0.11	0.6	0.34
P	0.807	0.701	0.756	0.508	0.080	0.003	0.68	0.66	0.02	0.49	0.12
N/P	5.42	5.53	5.72	6.45	0.53	0.17	0.7	0.81	0.18	0.91	0.24

[1] Seasons were arranged based on the dates of manure analyses.

[2] n=15

[3] n=25

[4] n=36

[5] n=54

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SUMMARY

N factors presented in the literature:

N Excretion

	Location	Excretion
ASAE (2001)	USA	105kg/yr
EMEP (1999)	Europe	100kg/cow/yr
Hutchings et al. (2001)	Denmark	125kg/cow/yr
Jarvis et al. (1987)	UK	75-89%NI
MWPS-18	USA	136kg/cow/yr
Powers and Van Horn (2001)	USA	77.1%NI
van der Putten and Ketelaars (1997)	The Netherlands	77.1%NI
Average		78.7%NI or 116kg/cow/yr
Our results		69.1%NI (125kg/cow/yr)

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Housing and Storage

% N entering the system	Location	Housing			Storage
		Summer	Winter	Overall	
Bussink and Oenema (1998)		up to 70	2-10		0-20
EMEP (1999)	Europe			12	6
Hutchings et al. (2001)	Denmark			2-15 (6)	5
Muck et al. (1984)	USA				3-39
Safley et al. (1986)	USA				22.6 (from excretion)
Sommer and Hutchings (1997)	Denmark				5
van der Putten and Ketelaars (1997)	The Netherlands		13		
Average		35	9.50	9.00	8.80
Our results			2.00-12.5 (7.25)		4-23.5 (19.8)

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% N entering the system	Location	Grazing	Spreading				
			Broadcast	Band spreader	Injection with open slits	Injection	Overall
Bussink and Oenema (1998)		0-28				0-5	up to 100 (TAN)
Chadwick et al. (2000)	UK			39 (TAN)	75 (TAN)	83 (TAN)	
EMEP (1999)	Europe	8					20
Hutchings et al. (2001)	Denmark	7	7-30	2-25		2	6
Jarvis et al. (1987)	UK	20-40					45-73
Sommer and Hutchings (1997)	Denmark	10-50 (TAN)					20-86
van der Putten and Ketelaars (1997)	The Netherlands	13 (3.5-34.6)		5-15	<5	1	
Average		17	18.5	7.8	5.00	1.83	34.5

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116.0 kg N excreted/year

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116.0 kg N excreted/year

Grazing

96.3 kg N available to the pasture

19.7 kg N lost from pasture

17.0 % of excreted N

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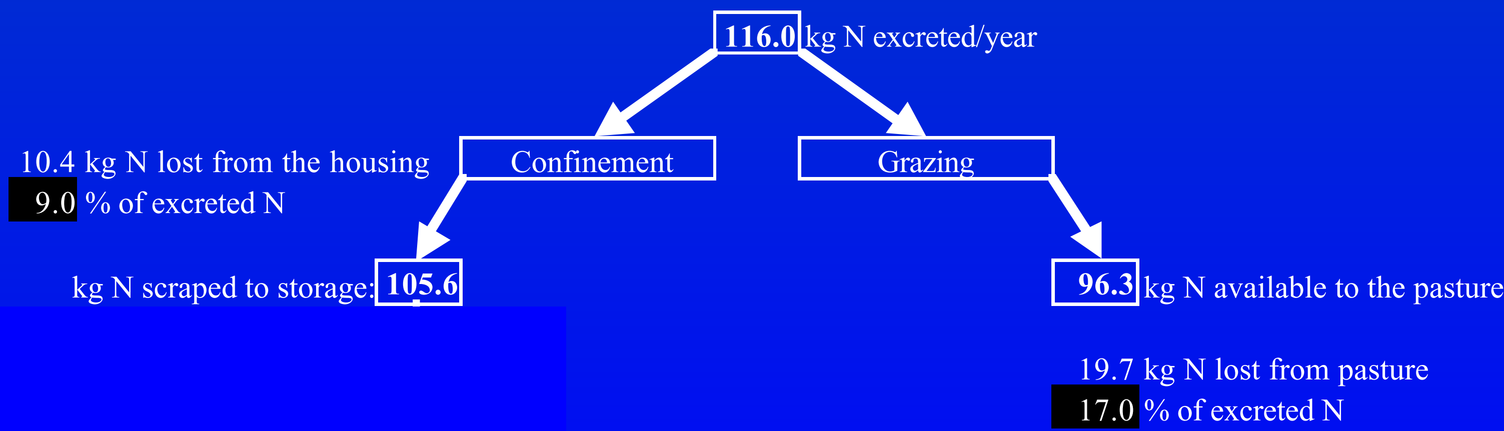
116.0 kg N excreted/year
Confinement
Grazing
10.4 kg N lost from the housing
9.0 % of excreted N
kg N scraped to storage: 105.6
96.3 kg N available to the pasture
19.7 kg N lost from pasture
17.0 % of excreted N

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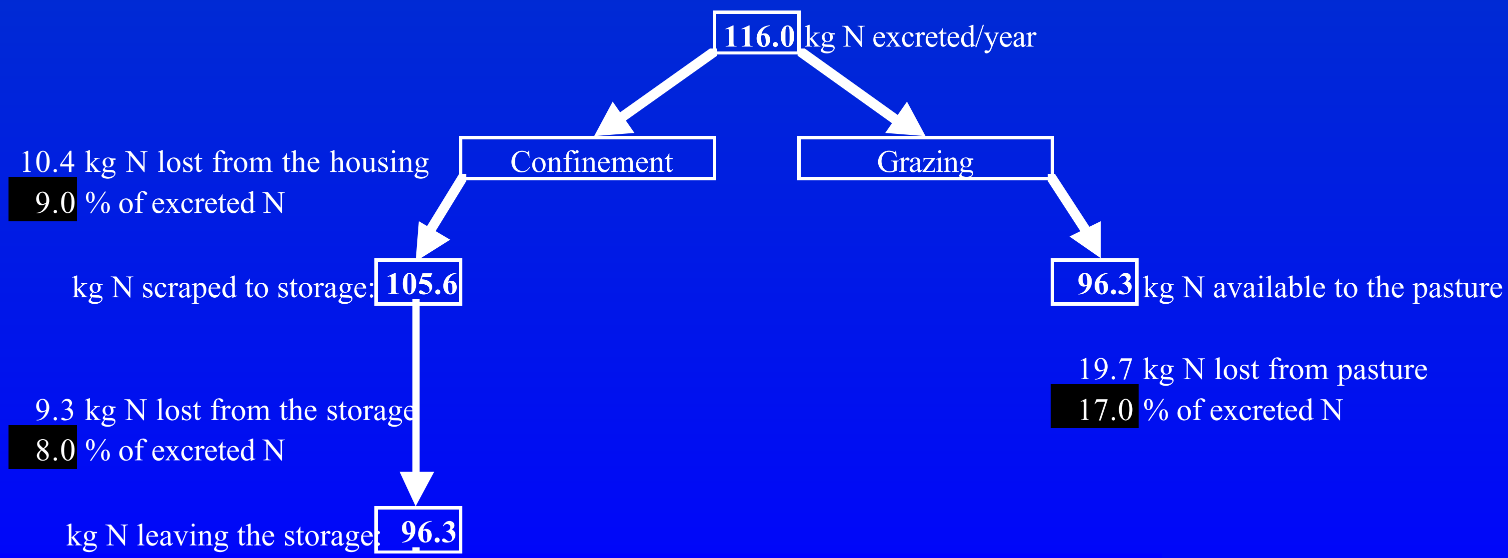

116.0 kg N excreted/year
Confinement
Grazing
10.4 kg N lost from the housing
9.0 % of excreted N
kg N scraped to storage: 105.6
96.3 kg N available to the pasture
19.7 kg N lost from pasture
17.0 % of excreted N
9.3 kg N lost from the storage
8.0 % of excreted N
kg N leaving the storage: 96.3

USDFRC

116.0 kg N excreted/year

Confinement

Grazing

10.4 kg N lost from the housing
9.0 % of excreted N

kg N scraped to storage: 105.6

9.3 kg N lost from the storage
8.0 % of excreted N

kg N leaving the storage: 96.3

Broadcasting: 78.5

15.4 % of excreted N
17.8 kg N lost after broadcasting

e pasture

ure

TOTALS

LOSSES (% excreted N)	**32.4**
LOSSES (kg/yr)	**37.5**

Broadcasting

USDFRC

116.0 kg N ex

Confinement

G

10.4 kg N lost from the housing
9.0 % of excreted N

kg N scraped to storage: 105.6

9.3 kg N lost from the storage
8.0 % of excreted N

kg N leaving the storage: 96.3

kg N available to the crops after:

Broadcasting: 78.5

Bandspreading: 88.8

15.4 % of excreted N
17.8 kg N lost after broadcasting

6.5 % of excreted N
7.5 kg N lost after bandspreading

	Broadcasting	Bandspreading
TOTALS		
LOSSES (% excreted N)	32.4	23.5
LOSSES (kg/yr)	37.5	27.2

USDFRC

eted/year

zing

96.3 kg N available to the pasture

19.7 kg N lost from pasture
17.0 % of excreted N

kg N leaving the storage: **96.3**

kg N available to the crops after:

Broadcasting: **78.5**
Bandspreading: **88.8**
Open holes: **91.5**

15.4 % of excreted N
17.8 kg N lost after broadcasting

6.5 % of excreted N
7.5 kg N lost after bandspreading

4.1 % of excreted N
4.8 kg N lost after injecting open slits

TOTALS	Broadcasting	Bandspreading	Open holes
LOSSES (% excreted N)	**32.4**	**23.5**	**21.2**
LOSSES (kg/yr)	**37.5**	**27.2**	**24.5**

USDFRC

116.0 kg N exc

Confinement

Gra

10.4 kg N lost from the housing
9.0 % of excreted N

kg N scraped to storage: 105.6

9.3 kg N lost from the storage
8.0 % of excreted N

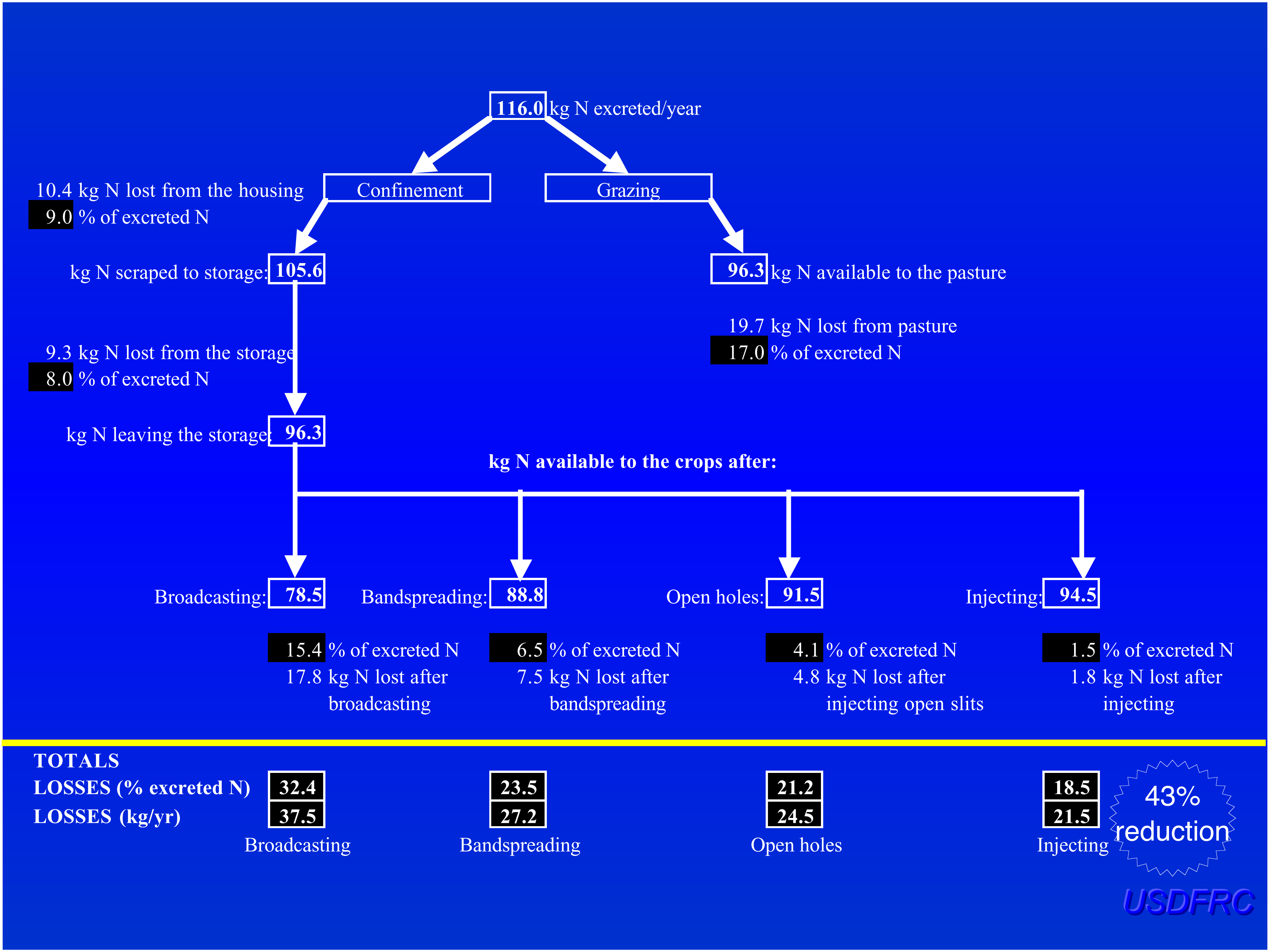
kg N leaving the storage: 96.3

kg N available to the crops after:

Broadcasting: 78.5	Bandspreading: 88.8	Open holes: 91.5	Injecting: 94.5
15.4 % of excreted N	6.5 % of excreted N	4.1 % of excreted N	1.5 % of excreted N
17.8 kg N lost after broadcasting	7.5 kg N lost after bandspreading	4.8 kg N lost after injecting open slits	1.8 kg N lost after injecting

TOTALS				
LOSSES (% excreted N)	32.4	23.5	21.2	18.5
LOSSES (kg/yr)	37.5	27.2	24.5	21.5
	Broadcasting	Bandspreading	Open holes	Injecting

USDFRC


116.0 kg N excreted/year
Confinement
Grazing
10.4 kg N lost from the housing
9.0 % of excreted N
kg N scraped to storage: 105.6
96.3 kg N available to the pasture
19.7 kg N lost from pasture
17.0 % of excreted N
9.3 kg N lost from the storage
8.0 % of excreted N
kg N leaving the storage: 96.3
kg N available to the crops after:
Broadcasting: 78.5
Bandspreading: 88.8
Open holes: 91.5
Injecting: 94.5
15.4 % of excreted N
17.8 kg N lost after broadcasting
6.5 % of excreted N
7.5 kg N lost after bandspreading
4.1 % of excreted N
4.8 kg N lost after injecting open slits
1.5 % of excreted N
1.8 kg N lost after injecting
TOTALS
LOSSES (% excreted N)
LOSSES (kg/yr)
32.4
37.5
Broadcasting
23.5
27.2
Bandspreading
21.2
24.5
Open holes
18.5
21.5
Injecting
43% reduction
USDFRC

USDFRC

Validation Protocol

- Overall status:
  - Limitations:
    - Assumed equal proportions of urine and feces for front and back free-stall;
    - Day to day variation in excretion rates, mainly for tie-stall sampling;
  - Perspective:
    - Correct urine:feces excretion ratio, according to DM or P, for free-stall sampling mix all???
    - Tie-stall: repeated protocol in Summer for two days.

USDFRC

In Stall Scraping

¥ Introduction

¥ Objective

— To evaluate the effect of scraping frequency on N disappearance, as estimated by N to P ratio.

¥ Materials and Methods

— Scrapers were set up for 2 or 6-times a day;

— Cross-over design, two sides of free stall;

— Sampling protocol followed that presented for Validation Protocol.

USDFRC

FARM #: 0

Farm name:

Farm owner (s):

Contact phone:

Type of animal facility:

Animal categories:

Milk yield records:

Nutrition consultant:

Diet composition:

MANURE MANAGEMENT

Scraping schedule (system and # of scrap ings/day):

Intermediat e facility schedule (manure pit or other):

Manure facility (type, management):

OBS:

Hauling schedule (time of loads; # of loads):

Period filling (date of last hauling):

Equipment (type, size, # loads/day):

Datasets

¥ Results

Effect of type of bedding on Total Nitrogen (**TN**), Total Phosphorus (**P**) and N to P ratio (**N/P**) of 130 dairy manure analyses (2 Labs: Minnesota and Wisconsin), regardless of storage type.

%DM	**Inorganic**[1]	**Organic**[2]	**SEM**	***P*** $\leq$
TN	3.22	3.88	0.19	0.02
P	0.584	0.713	0.035	0.01
N/P	5.84	5.73	0.24	0.73

[1] Manure samples with accompanying information indicating that sand or no bedding was used. This also included samples where there was no information about bedding (n=56).

[2] Manure samples with accompanying information indicating that straw, hay, grass, sawdust, shaving or oat hulls (n=74).

USDFRC

Datasets

¥ Results

Effect of wall profile of manure storage on Total Nitrogen (**TN**), Total Phosphorus (**P**) and N to P ratio (**N/P**) of 99 dairy manure samples (3 labs: Pennsylvania, Ohio and Wisconsin).

%DM	**Inclined**[1]	**Vertical**[2]	**SEM**	***P*** $\leq$
TN	4.18	5.33	0.36	0.04
P	0.765	0.866	0.06	0.3
N/P	5.79	6.24	0.36	0.41

[1] n=86

[2] n=13

USDFRC

Datasets

¥ Results

Effect of loading (bottom or top) of manure into the storage on Total Nitrogen (**TN**), Total Phosphorus (**P**) and N to P ratio (**N/P**) of 63 dairy manure samples (1 lab: Pennsylvania).

%DM	**Bottom**	**Top**	**SEM**	***P*** $\leq$
TN	4.91	3.93	0.42	0.11
P	0.917	0.805	0.05	0.12
N/P	5.36	4.90	0.31	0.30

[1] n=21

[2] n=42

Datasets

¥ Results

Effect of covering the manure storage on Total Nitrogen (TN), Total Phosphorus (P) and N to P ratio (N/P) of 36 dairy manure (1 lab: Pennsylvania).

%DM	Covered	Uncover	SEM	*P* $\leq$
TN	5.58	4.36	0.65	0.21
P	0.872	0.830	0.070	0.69
N/P	6.12	5.38	0.44	0.25

[1] n=11

[2] n=25

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Procedures

¥ Freeze Drying TN Protocol

¥ Sampling Protocol

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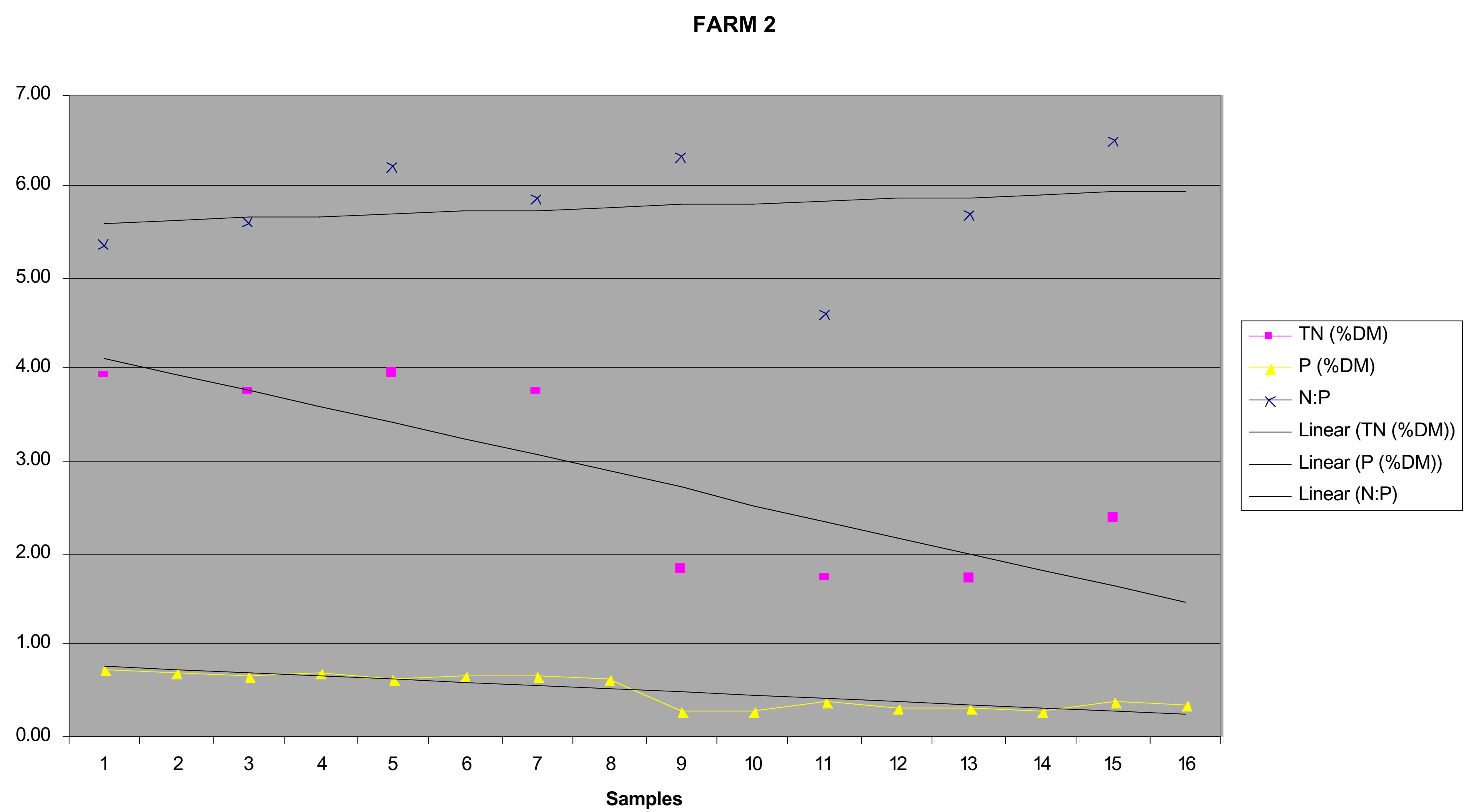
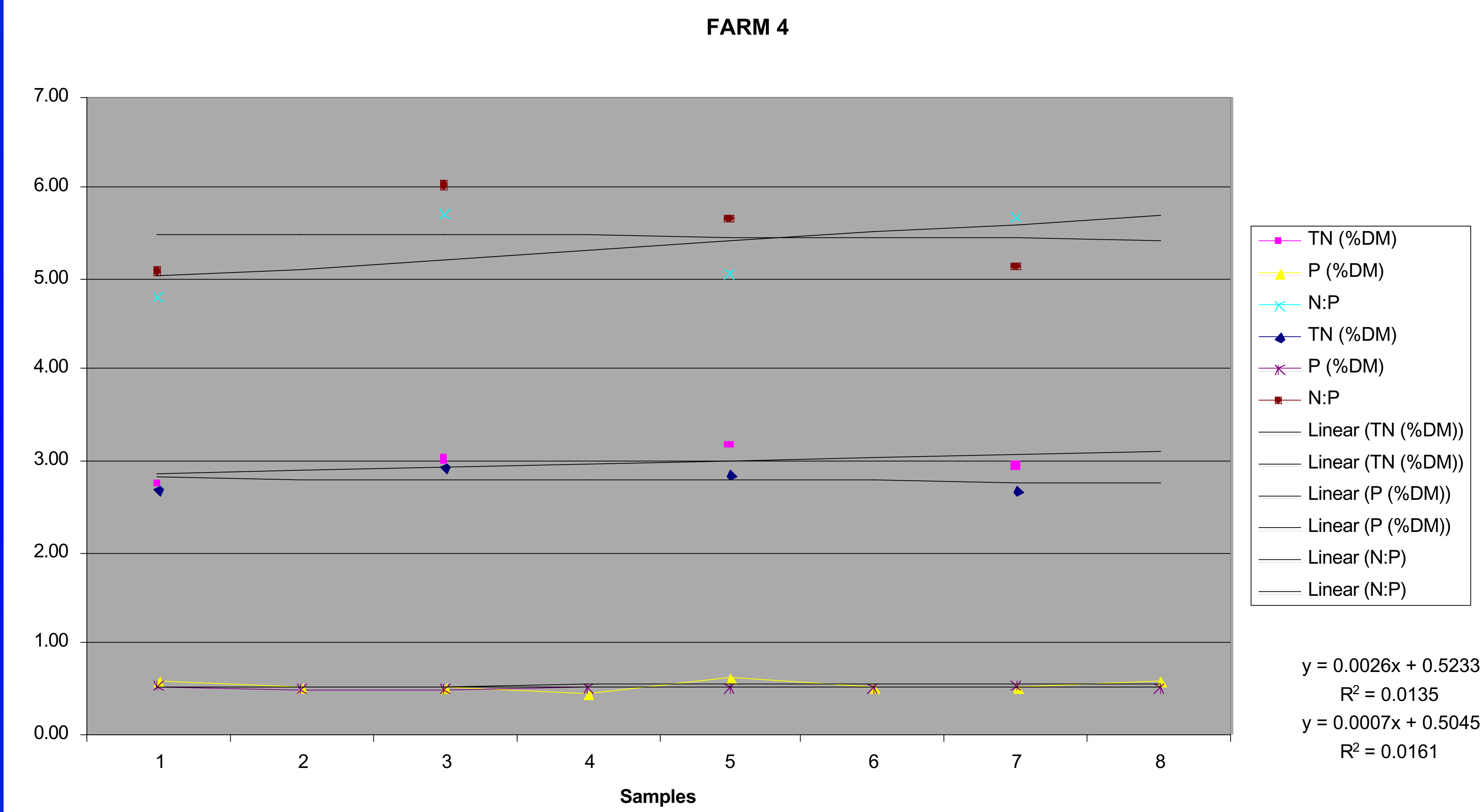


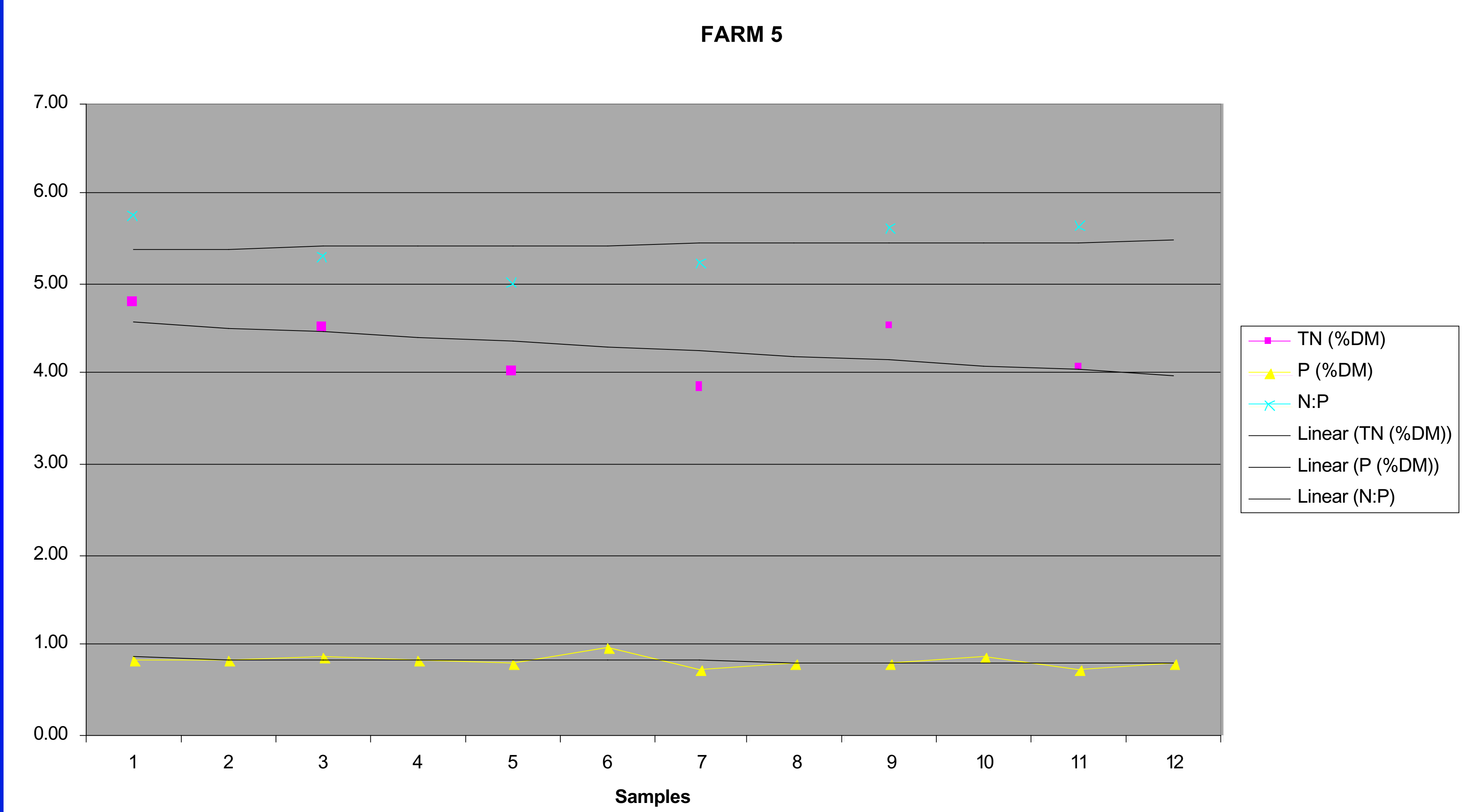
FARM 2
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Samples
TN (%DM)
P (%DM)
N:P
Linear (TN (%DM))
Linear (P (%DM))
Linear (N:P)

USDFRC

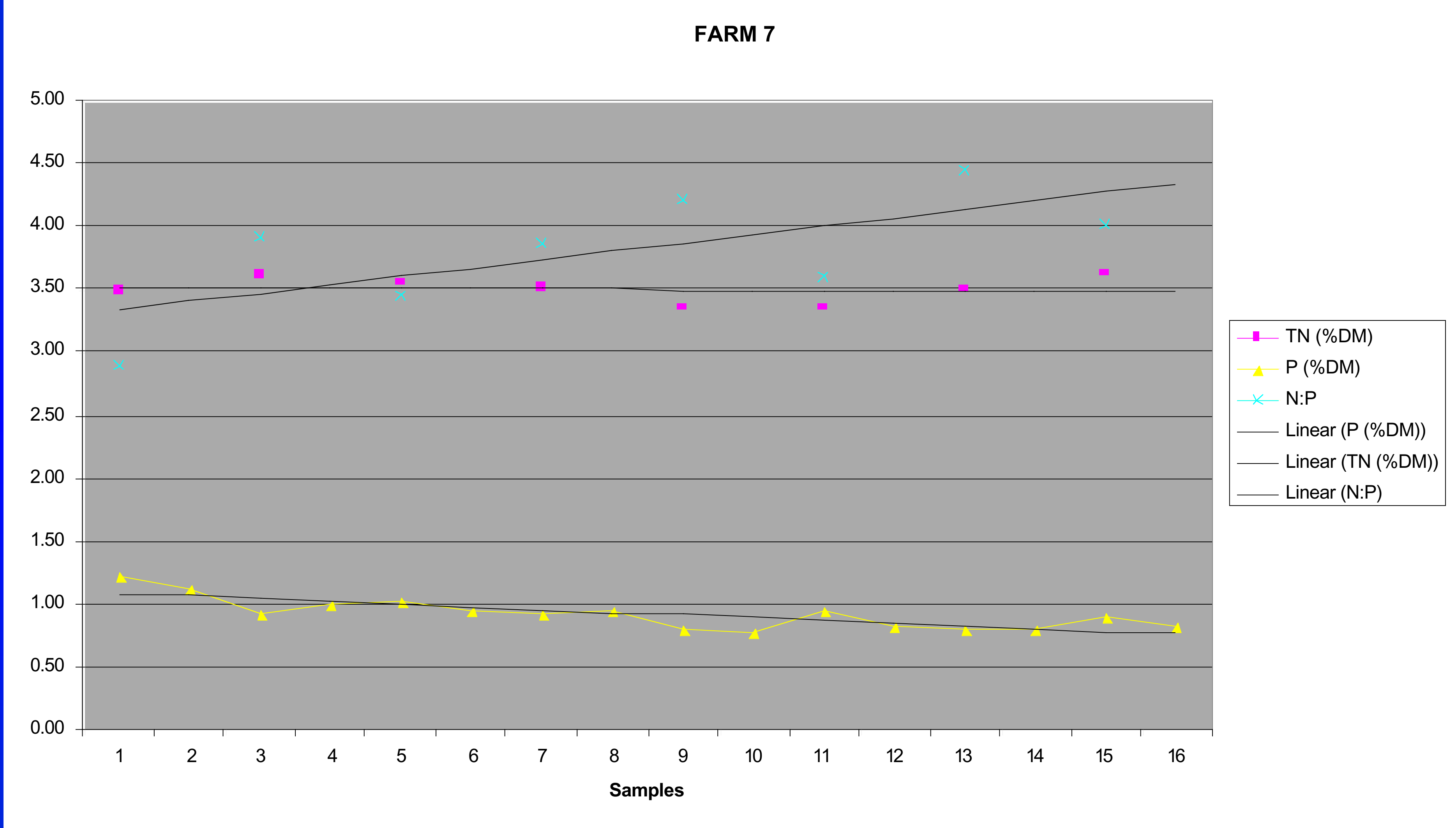


FARM 4
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1
2
3
4
5
6
7
8
Samples
TN (%DM)
P (%DM)
N:P
TN (%DM)
P (%DM)
N:P
Linear (TN (%DM))
Linear (TN (%DM))
Linear (P (%DM))
Linear (P (%DM))
Linear (N:P)
Linear (N:P)
y = 0.0026x + 0.5233
R2 = 0.0135
y = 0.0007x + 0.5045
R2 = 0.0161

USDFRC

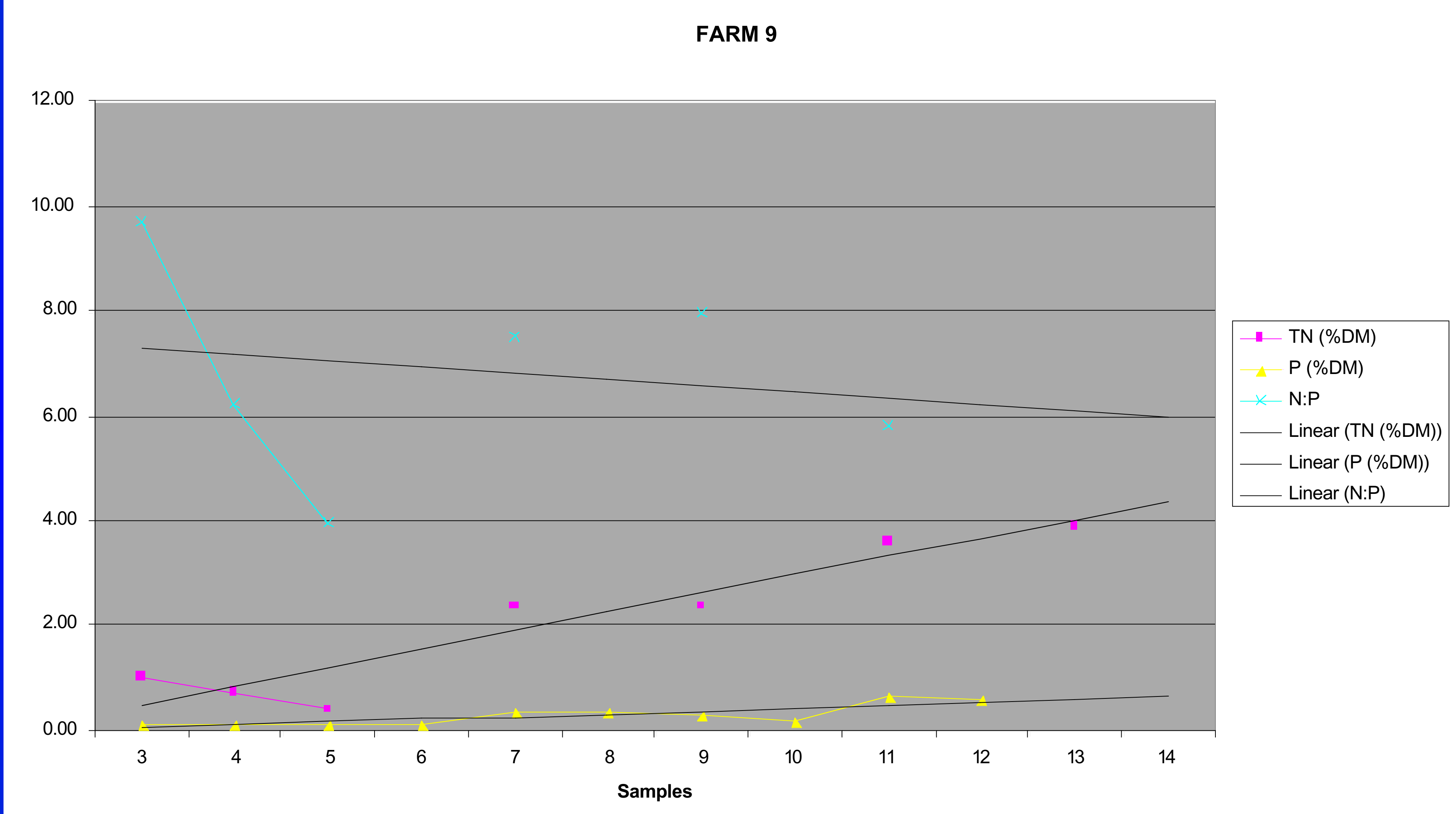

FARM 5
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1
2
3
4
5
6
7
8
9
10
11
12
Samples
TN (%DM)
P (%DM)
N:P
Linear (TN (%DM))
Linear (P (%DM))
Linear (N:P)

USDFRC

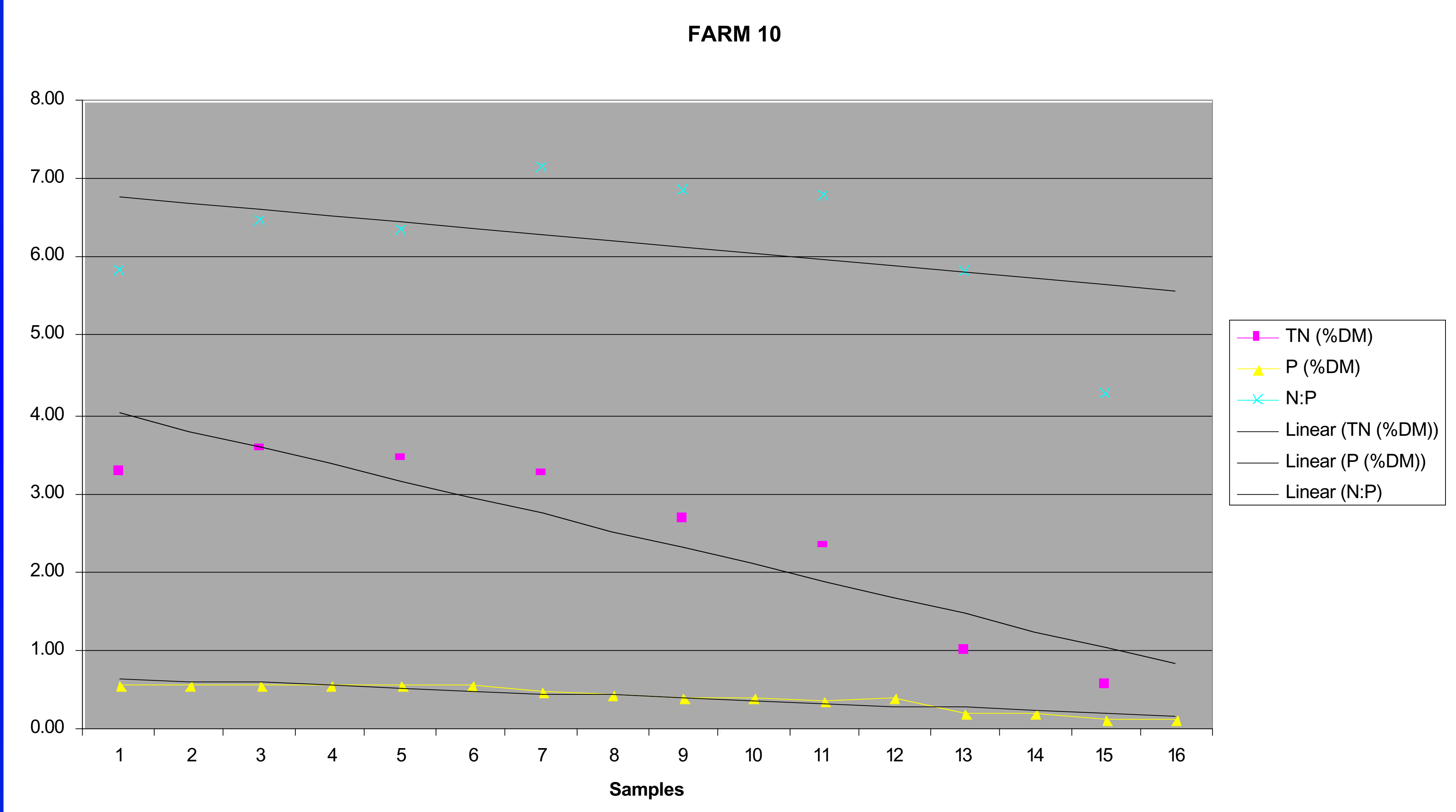


FARM 7
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Samples
TN (%DM)
P (%DM)
N:P
Linear (P (%DM))
Linear (TN (%DM))
Linear (N:P)

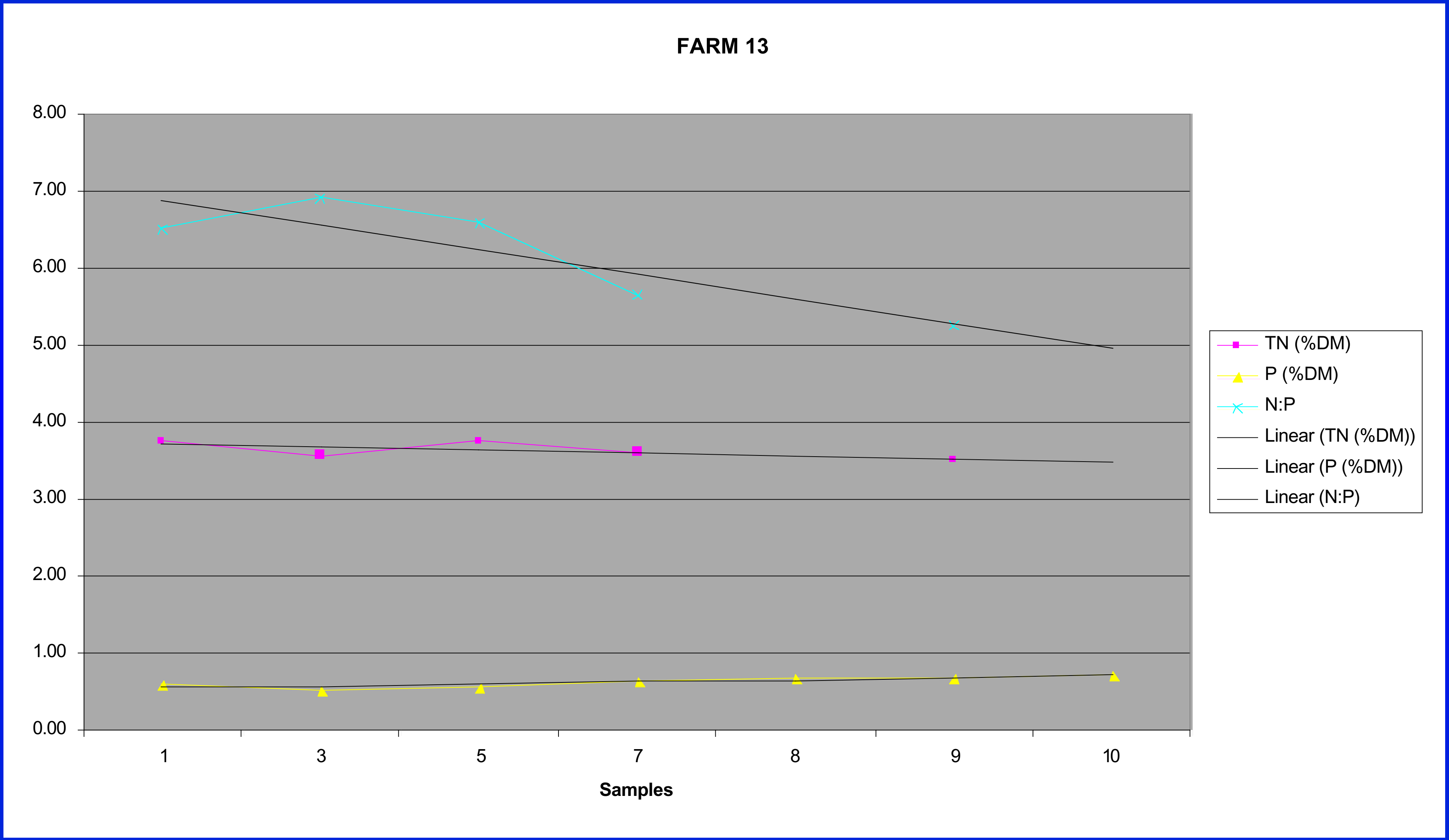
USDFRC


FARM 9
12.00
10.00
8.00
6.00
4.00
2.00
0.00
3
4
5
6
7
8
9
10
11
12
13
14
Samples
TN (%DM)
P (%DM)
N:P
Linear (TN (%DM))
Linear (P (%DM))
Linear (N:P)

USDFRC


FARM 10
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Samples
TN (%DM)
P (%DM)
N:P
Linear (TN (%DM))
Linear (P (%DM))
Linear (N:P)

USDFRC


FARM 13
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1
3
5
7
8
9
10
Samples
TN (%DM)
P (%DM)
N:P
Linear (TN (%DM))
Linear (P (%DM))
Linear (N:P)

USDFRC